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Gulf Region

Canadian Science Advisory Secretariat
Science Response 2017/003

UPDATED INDICES OF ABUNDANCE TO 2016 FOR STOCKS OF FOUR GROUNDFISH SPECIES FROM NAFO DIV. 4T

Context

DFO has conducted research vessel (RV) surveys in the southern Gulf of St. Lawrence (sGSL), Northwest Atlantic Fisheries Organization (NAFO) Area 4T using standardized protocols each September since 1971. In addition, two sentinel programs, a sentinel longline survey beginning in 1995 and an August sentinel bottom-trawl survey beginning in 2003, have been conducted by DFO in collaboration with the fishing industry. Results of these surveys provide information on trends in abundance and biomass for groundfish species in the 4T area. Along with other sources of information, these indices are a critical part of science-based stock assessments, nevertheless a full assessment would be required to evaluate the impacts of management measures on population status. DFO Fisheries and Aquaculture Management (FAM) Gulf Region requested updated RV and sentinel survey information to 2016 for Atlantic Cod, American Plaice, White Hake, and Yellowtail Flounder from NAFO Area 4T. This Science Response Report results from the Science Response Process of December 20 2016, on the review of the update of indices of abundance to 2016 of four groundfish species (Atlantic Cod 4TVn, American Plaice 4T, White Hake 4T, and Yellowtail Flounder 4T) assessed and managed by DFO Gulf Region. For Atlantic Cod, the analysis of the indicator relative to an identified trigger value is presented to determine if a full stock re-assessment may be warranted earlier than March 2019, the next scheduled assessment of the four-year stock assessment cycle.

Background

The four species, Atlantic Cod, American Plaice, White Hake, and Yellowtail Flounder, covered by this report are under commercial fishery moratoria (directed fisheries are closed) or have small annual Total Allowable Catches (TAC) (Table 1).

Table 1. Groundfish species and stocks addressed in this report and the total allowable catch in 2016 for each species.

Species and stock	Total allowable catch in 2016
Atlantic Cod (*Gadus morhua*) 4T-4Vn(Nov-April)	300 t (no directed commercial fishery)[1]
American Plaice (*Hippoglossoides platessoides*) 4T	250 t
White Hake (*Urophycis tenuis*) 4T	30 t (no directed commercial fishery)[1]
Yellowtail Flounder (*Limanda ferruginea*) 4T	225 t

[1] to cover by-catch in other groundfish fisheries, a limited recreational fishery, for scientific purposes, and negotiated Aboriginal food, social and ceremonial fisheries agreements.

The September RV survey of the sGSL follows a stratified random sampling design (Fig. 1) and includes sampling of fish and invertebrates using a bottom trawl. The RV survey was designed to provide abundance trends for fish and invertebrates distributed between depths of about 20 m to 350 m. This survey, conducted annually since 1971, is the primary source of data for

monitoring trends in species distribution, abundance, and biological characteristics (e.g., size and age composition, growth) in the sGSL (for details see Savoie 2016). The same stratification scheme has been used since 1971, with the exception of the addition of three inshore strata (401 to 403) in 1984. Unless otherwise stated, the analyses presented are based on the 24 strata (415 to 439) sampled since 1971. The survey indices have been standardized for changes in survey vessels, gears, and protocols which have occurred over the time series (Benoît and Swain 2003; Benoît 2006). Survey indices are expected to be proportional to abundance for most species. Data from 2003 were excluded for the RV survey because it was incomplete.

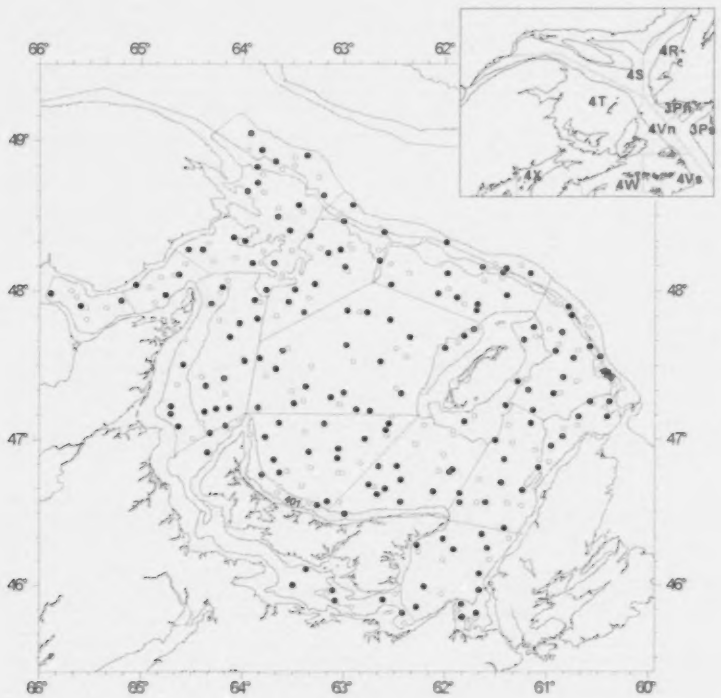

Figure 1. Location of the fishing sets from the September RV survey (black; 162 tows) and the August sentinel bottom-trawl survey (white; 146 tows) in 2016. Inset panel shows the NAFO Division 4T and neighbouring management areas.

The sentinel bottom-trawl survey, conducted each August since 2003, uses the same stratified random design as the RV survey (Fig. 1). The survey is conducted annually following standardized protocols using four commercial vessels equipped with identical fishing gear (Savoie 2016). For the widely distributed species, Atlantic Cod and American Plaice, abundance and biomass indices have been standardized for any differences in fishing efficiency between vessels. This is not possible for Yellowtail Flounder and White Hake, species with more restricted distributions.

The sentinel longline program for the sGSL provides an index for Atlantic Cod (Swain et al. 2015). Fishing is conducted at fixed sites in near-shore areas distributed throughout the sGSL. Each site was fished several times a year from July to October. A standardized annual index of catch rates for Atlantic Cod for 1995 to 2016 was obtained using a statistical analysis that accounted for differences in catch rates between months and sites.

Analysis and Response

Indices by species

Atlantic Cod

The last full assessment of the Atlantic Cod stock of the sGSL, NAFO Divs. 4T-4Vn (Nov. - April), was conducted in March 2015 using data up to 2014 (Swain et al. 2015; DFO 2016a). This analysis led to the conclusion that adult biomass was still at a low level and well below the limit reference point (LRP) for this stock, the level below which the stock is considered to have suffered serious harm to its productivity. Extremely high natural mortality of Atlantic Cod 5 years and older makes the recovery of this stock highly improbable, even in the absence of fishing. The directed commercial fishery for sGSL Atlantic Cod was closed from 1994 to 1997, again in 2003, and has remained closed since 2009.

During the 46-year time series, the RV survey biomass index (weight in kg per tow) for Atlantic Cod of pre-commercial (< 42 cm) lengths reached its lowest observed level in 2010 to 2012 (Fig. 2a) and has again decreased to a similarly low level in 2016. Uncertainty in the index was high in 2002, 2009 and 2013 and the relatively higher indices for these years did not result in subsequent increases in biomass at larger sizes.

The RV biomass index for commercial-sized (≥ 42 cm) Atlantic Cod has been at a low level since the early 1990s (Fig. 2b). The index declined from the early 2000s to the lowest levels observed in the 46-year time series in 2011 and 2012. The index has remained near this record low level.

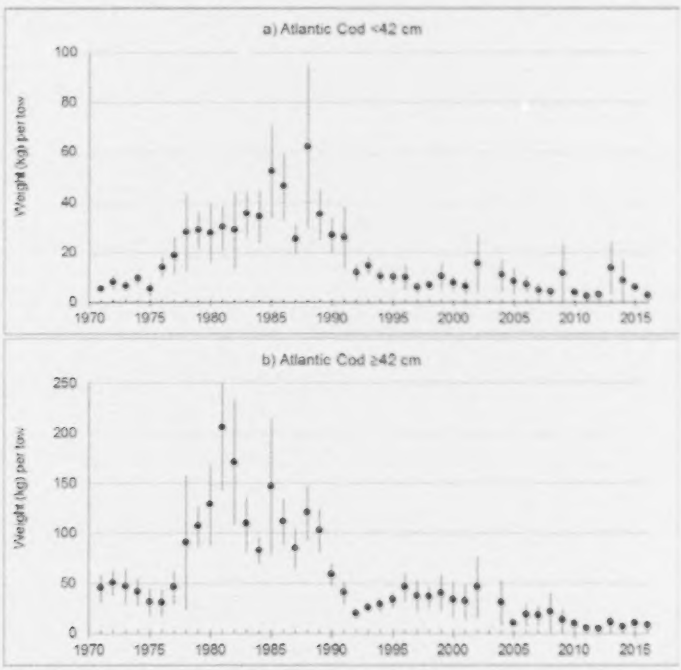

Figure 2. RV survey biomass indices (weight in kg per tow) for Atlantic Cod of pre-commercial (< 42 cm; upper panel a) and commercial (≥ 42 cm; lower panel b) lengths, 1971 to 2016. These size classes correspond approximately to juvenile and adult Atlantic Cod, respectively. Circles represent mean values and vertical lines denote approximate 95% confidence limits (± 2 standard errors).

The biomass index for Atlantic Cod from the sentinel bottom-trawl survey has declined over the 14-year time series (Fig. 3). Except for a highly uncertain estimate in 2014, the index has been at record low levels since 2012.

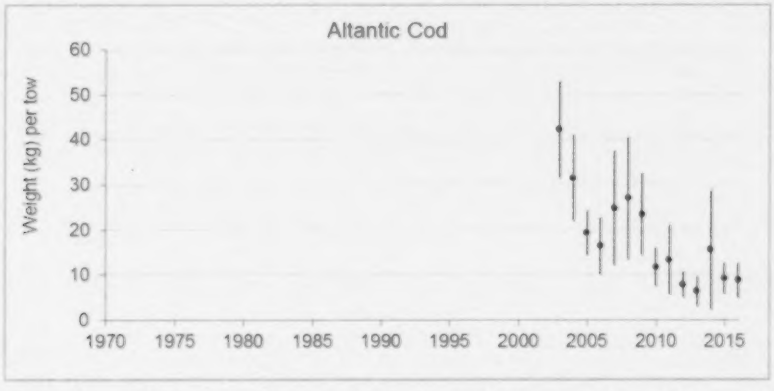

Figure 3. Biomass index (weight in kg per tow) for Atlantic Cod (all sizes) from the sentinel bottom-trawl survey, 2003 to 2016. Circles represent mean values and vertical lines denote approximate 95% confidence limits.

The Cod biomass index (kg per 1000 hooks) from the sentinel longline program steadily declined from 2004 to a record-low level in 2011 and has remained near this low level since then (Fig. 4).

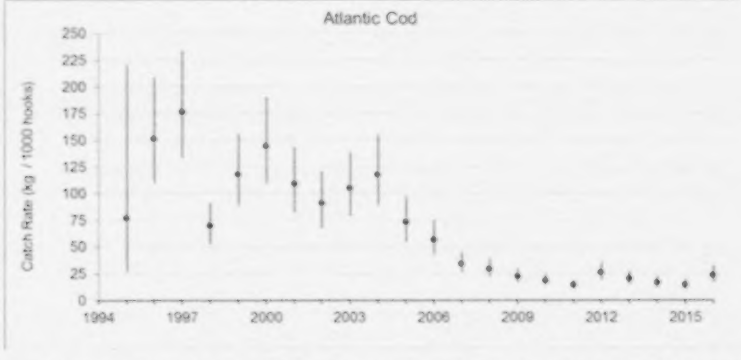

Figure 4. Standardized catch rate (kg per 1000 hooks) for Atlantic Cod (all sizes) from the sentinel longline program, 1995 to 2016. Circles represent mean values and vertical lines denote approximate 95% confidence limits.

This year is the mid-way point in the multi-year assessment cycle for Atlantic Cod. As per DFO (2016a, 2016b), it was determined that an early assessment would be warranted in the winter of 2017 if the three-year moving average of the RV survey biomass index (in trawlable biomass) for Atlantic Cod ≥ 42 cm exceeded the LRP re-scaled to trawlable biomass (Swain et al. 2015). In 2016, this index was 30% of the re-scaled LRP (Fig. 5).

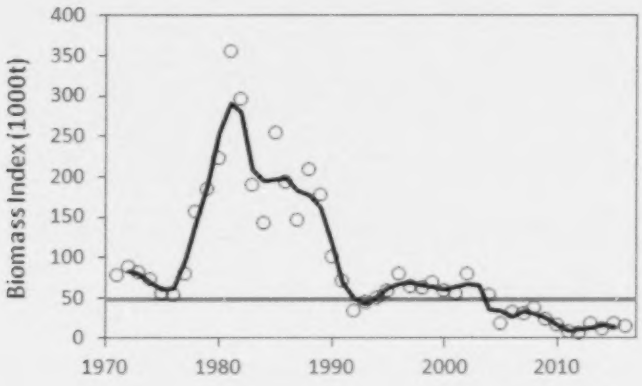

Figure 5. The observed RV biomass index for Atlantic Cod ≥ 42 cm (circles) and its three-year moving average (solid black line). The horizontal red line is the limit reference point (LRP) at the scale of the biomass index (trawlable biomass) (Swain et al. 2015; DFO 2016a).

American Plaice

The status of American Plaice in the sGSL, NAFO Div. 4T, was last reviewed in March 2016 as part of a DFO Ecosystems and Fisheries Management multi-year management plan for May 2016 to May 2021 (DFO 2016c; Ricard et al. 2016). Including data up to 2015, the review concluded that the NAFO Div. 4T stock of American Plaice was at an all-time low level of abundance and under current productivity conditions the spawning stock biomass was expected to decrease over the subsequent five years even with no fishery related losses.

The RV survey biomass index for pre-commercial sizes (< 30 cm) of American Plaice declined steadily from 1991 to 1999 and has remained at a near record low level (Fig. 6a). The biomass index for commercial sizes (≥ 30 cm) shows the same pattern (Fig. 6b).

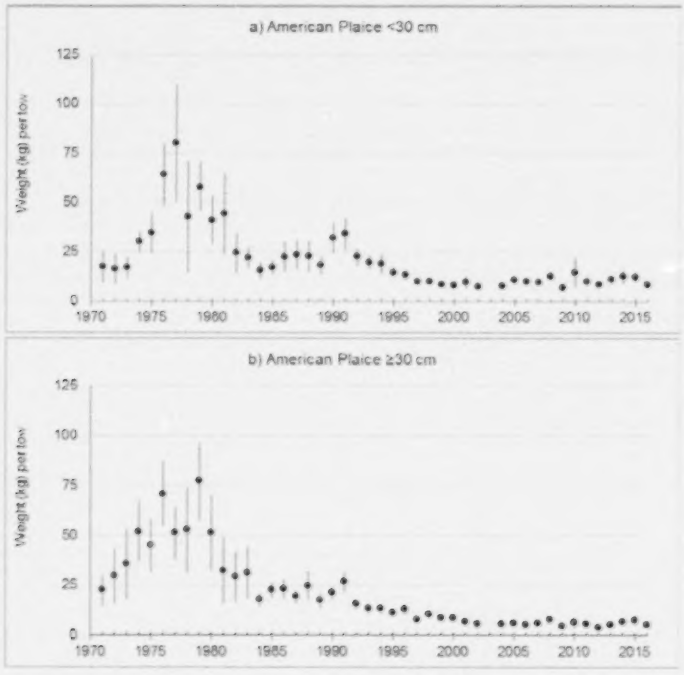

Figure 6. RV survey biomass indices (weight in kg per tow) for American Plaice of pre-commercial (< 30 cm; upper panel a) and commercial (≥ 30 cm; lower panel b) lengths, 1971 to 2016. These size classes correspond approximately to juvenile and adult American Plaice, respectively. Circles represent mean values and vertical lines denote approximate 95% confidence limits.

The biomass index for American Plaice from the sentinel bottom-trawl survey has declined since the start of the time series in 2003 (Fig. 7). The 2016 value remains at a low level but is higher than the time series lows observed from 2013 to 2015.

Figure 7. Biomass index (weight in kg per tow) for American Plaice (all sizes) from the sentinel bottom-trawl survey, 2003 to 2016. Circles represent mean values and vertical lines denote approximate 95% confidence limits.

White Hake

A Recovery Potential Assessment of the Designatable Unit of White Hake in the sGSL was conducted in January 2015 (DFO 2016d; Swain et al. 2016). That review concluded that at

recent levels of fishing effort, catches associated with commercial fisheries directing for groundfish have a negligible impact on the population trajectory. The current high levels of natural mortality (80 to 90% annually) are the most important factor limiting the recovery of this population.

The biomass index for pre-commercial (< 45 cm) sizes of White Hake has been relatively low in most years since 1993 (Fig. 8a), though the decline in the index for these small sizes was not as sharp as the decline at larger sizes. The index in 2013 was at the lowest level observed in the time series. The pre-commercial biomass index was at relatively high levels in 2000, 2007 and 2014, but uncertainty in the index was very high in all three years and these values were not reflected in increased biomass at commercial sizes in subsequent years. The RV survey biomass index for commercial-sized (≥ 45 cm) White Hake declined sharply between the mid-1980s and mid-1990s, and has since been at a very low level (Fig. 8b). This index increased slightly from 2014 to 2016 from the record low 2013 level.

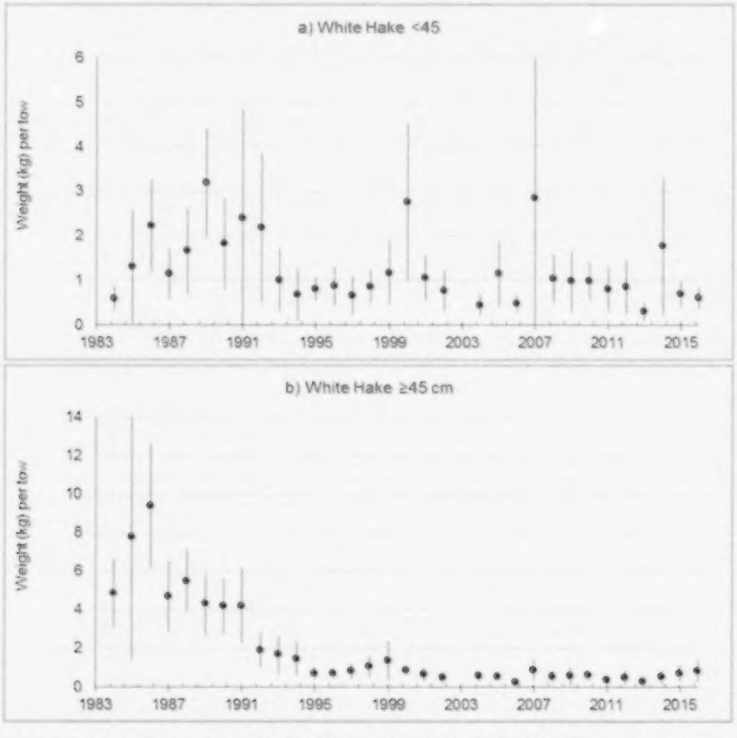

Figure 8. RV survey biomass indices (weight in kg per tow) for White Hake of pre-commercial (< 45 cm; upper panel a) and commercial (≥ 45 cm; lower panel b) lengths, 1984 to 2016. These size classes correspond approximately to juvenile and adult White Hake, respectively. Circles represent mean values and vertical lines denote approximate 95% confidence limits. Indices are based on strata 401 and 403 in addition to the standard strata 415 to 439; hence the time series begins in 1984 instead of 1971.

The White Hake biomass index from the sentinel bottom-trawl survey declined from the start of the series to very low levels in 2012 and 2013 (Fig. 9). The index subsequently increased to a level similar to the mid-2000s when abundance was already very low.

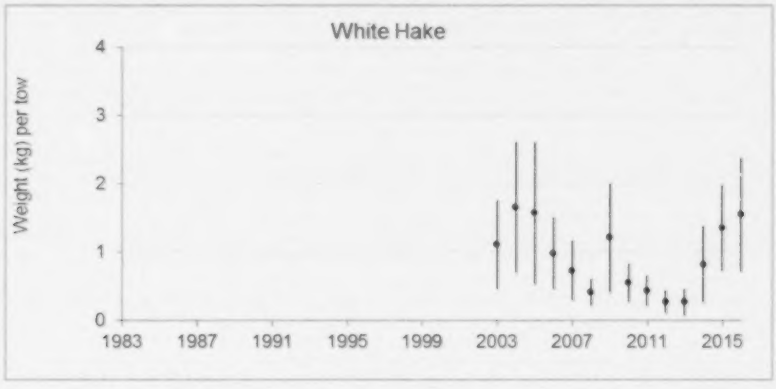

Figure 9. Biomass index (weight in kg per tow) for White Hake (all sizes) from the sentinel bottom-trawl survey, 2003 to 2016. Circles represent mean values and vertical lines denote approximate 95% confidence limits.

Yellowtail Flounder

The status of Yellowtail Flounder in the sGSL, NAFO Div. 4T, was last reviewed in March 2016 as part of a DFO Ecosystems and Fisheries Management multi-year management plan for May 2016 to May 2021 (DFO 2016e; Surette and Swain 2016). Including data up to 2015, the review concluded that the abundance indices, in number, from the RV survey had been stable since the mid-eighties for this stock. Nevertheless, corresponding biomass indices have decreased due to a shift in modal size. Fishing mortality is estimated to be generally low and represents a small proportion of the estimated total mortality.

The RV survey biomass index for pre-commercial sized (< 25 cm) Yellowtail Flounder increased greatly from the mid-1980s to the mid-2000s and remained high to 2015 (Fig. 10a).The value of the index in 2016 was lower than in 2015 and at a level observed during the late 1980s. In contrast, the biomass index for commercial-sized (≥ 25 cm) Yellowtail Flounder decreased sharply from the mid-1990s to 2012. This index showed some increase in 2013 to 2015 but decreased to a record low in 2016 (Fig. 10b).

The biomass index for Yellowtail Flounder from the sentinel bottom-trawl survey has decreased since 2003 to the lowest level on record in 2016 (Fig. 11).

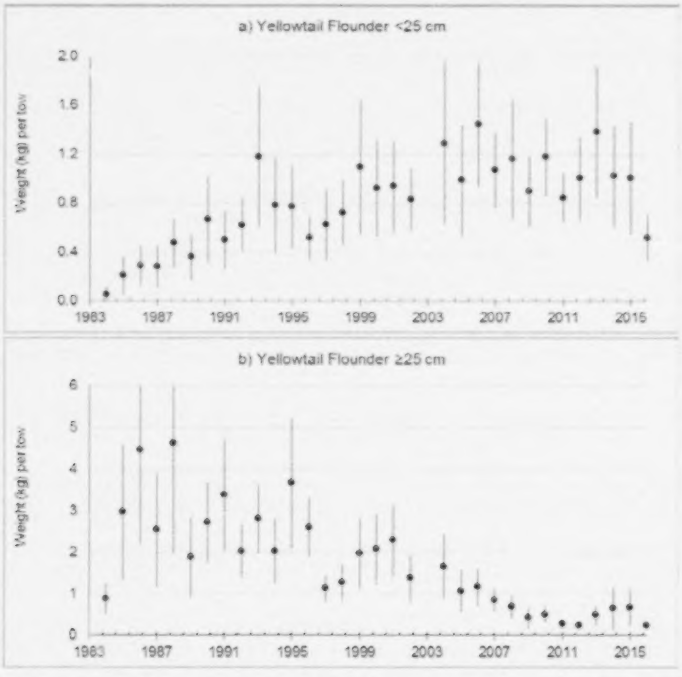

Figure 10. RV survey biomass indices (weight in kg per tow) for Yellowtail Flounder of pre-commercial (< 25 cm; upper panel a) and commercial (≥ 25 cm; lower panel b) lengths, 1984 to 2016. These size classes correspond approximately to juvenile and adult Yellowtail Flounder, respectively. Circles represent mean values and vertical lines denote approximate 95% confidence limits. Indices are based on strata 401 to 403 in addition to the standard strata 415 to 439; hence the indices begin in 1984 instead of 1971.

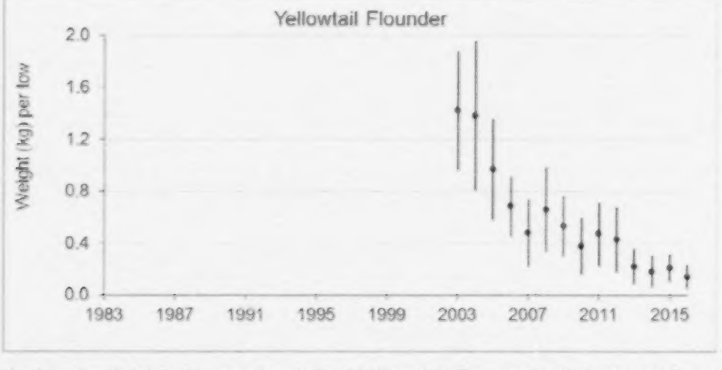

Figure 11. Biomass index (weight in kg per tow) for Yellowtail Flounder (all sizes) from the sentinel bottom-trawl survey, 2003 to 2016. Circles represent mean values and vertical lines denote approximate 95% confidence limits.

Conclusions

The RV and sentinel biomass indices for commercial sizes of Atlantic Cod, American Plaice, White Hake, and Yellowtail Flounder indicate that there has been no improvement in biomass for these stocks since their last assessment. In all cases, the indices indicate that commercial biomass remains at or near record low levels.

For Atlantic Cod, an assessment before the scheduled four-year cycle would be recommended if the three-year moving average of the RV survey biomass index for Atlantic Cod ≥ 42 cm exceeded the re-scaled LRP of trawlable biomass (DFO 2016a). In 2016, the moving average value of this index was 30% of the rescaled LRP and the indicator trigger value has not been reached. As a result, a stock reassessment is not warranted and the previous advice for the fishery for this stock remains appropriate.

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January 6, 2017

Sources of information

This Science Response Report results from the Science Response Process of December 20 2016, on the review of the update of indices of abundance to 2016 of four groundfish species (Atlantic Cod 4TVn, American Plaice 4T, White Hake 4T, and Yellowtail Flounder 4T) assessed and managed by DFO Gulf Region. No other publications will be produced from this process.

Benoît, H.P. 2006. Standardizing the southern Gulf of St. Lawrence bottom-trawl survey time series: results of the 2004-2005 comparative fishing experiments and other recommendations for the analysis of the survey data. DFO Can. Sci. Advis. Sec. Res. Doc. 2006/008: 127 p.

Benoît, H.P., and Swain, D.P. 2003. Standardizing the southern Gulf of St. Lawrence bottom-trawl survey time series: adjusting for changes in research vessel, gear and survey protocol. Can. Tech. Rep. Fish. Aquat. Sci., 2505: iv + 95 p.

DFO. 2016a. Assessment of Atlantic Cod (*Gadus morhua*) in the southern Gulf of St. Lawrence (NAFO Div. 4T-4Vn (Nov. – April)) to 2014. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/061.

DFO. 2016b. Guidelines for providing interim-year updates and science advice for multi-year assessments. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2016/020.

DFO. 2016c. Stock assessment of American Plaice (*Hippoglossoides platessoides*) of the southern Gulf of St. Lawrence (NAFO Div. 4T) to 2015. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2016/031.

DFO. 2016d. Recovery Potential Assessment for White Hake (*Urophycis tenuis*): Population of the Southern Gulf of St. Lawrence. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2016/034.

DFO. 2016e. Stock assessment of Yellowtail flounder (*Limanda ferruginea*) of the southern Gulf of St. Lawrence (NAFO Div. 4T) to 2015. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2016/033.

Ricard, D., Morin, R., Swain, D.P., and Surette, T. 2016. Assessment of the southern Gulf of St. Lawrence (NAFO Division 4T) stock of American Plaice (*Hippoglossoides platessoides*), March 2016. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/057. ix + 43 p.

Savoie, L. 2016. Indices of abundance to 2014 for six groundfish species based on the September research vessel and August sentinel vessel bottom-trawl surveys in the southern Gulf of St. Lawrence. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/085. v + 52 p.

Surette, T., and Swain, D.P. 2016. The Status of Yellowtail Flounder in NAFO Division 4T to 2015. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/058. x + 74 p.

Swain, D.P., Savoie, L., Cox, S.P., and Aubry, E. 2015. Assessment of the southern Gulf of St. Lawrence Atlantic Cod (*Gadus morhua*) stock of NAFO Div. 4T and 4Vn (November to April), March 2015. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/080. xiv + 137 p.

Swain, D.P., Savoie, L., and Cox, S.P. 2016. Recovery potential assessment of the Southern Gulf of St. Lawrence Designatable Unit of White Hake (*Urophycis tenuis* Mitchill), January 2015. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/045. vii + 109 p.

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